

## CLAIMS

[0052] What is claimed is:

1. A color bar code system comprising:

a camera reader to read at least one bar code, said bar code being formed of a subset of N bar code colors;

a color association unit to associate each point in a color space with one of said bar code colors, said color association unit being calibratable to the range of colors that said camera reader is expected to produce given at least one environmental condition in which it operates;

an identifier to use said color association unit to identify an item associated with said bar code from the output of said camera reader.

2. A system according to claim 1 and wherein said at least one environmental condition is at least one of the following conditions: a lighting condition, a camera condition and a printed color condition.

3. A system according to claim 1 and wherein said color association unit is a lookup table.

4. A system according to claim 2 and wherein said color association unit is at least two lookup tables, one per lighting condition.

5. A calibration unit for a color bar code system, the calibration unit comprising:

a color chart generator to generate at least one color chart of color patches of the N bar code colors utilized by said color bar code system; and

a color calibrator to receive the design of said color chart from said generator and the output of a camera reader upon reading said color chart under varying conditions and to associate said output corresponding to each said color patch, per condition, with one of said N bar code colors.

6. A unit according to claim 5 and also comprising a color classifier to associate each data point in a color space with one of said N bar code colors using the output of said color calibrator.

7. A unit according to claim 6 and wherein said color classifier comprises a k-nearest neighbor classifier.

8. A unit according to claim 7 wherein said k-nearest neighbor classifier comprises:

neighbor extracting means for finding at least k neighboring training vectors of a test point and for extracting the bar code color associated with each said neighbor;

majority defining means for weighting said bar code colors of said neighboring training vectors by the ratio of said bar code colors within the entirety of said training vectors and for selecting a majority bar code color;

means for activating said neighbor extracting means and said majority defining means on  $k/2$  and  $2k$  vectors, if no majority was found; and

means for selecting a majority bar code color from the output of said majority defining means upon each of said  $k$ ,  $k/2$  and  $2k$  operations.

9. A unit according to claim 8 wherein said neighbor extracting means comprises:

means for extracting all training vectors within a minimum radius;

means for extracting a minimum of k nearest neighbors within a maximum radius;

means for extracting  $k/2$  neighbors from the entire color space; and

means for activating each of said means for extracting until at least k neighbors have been extracted.

10. A method comprising:

identifying an item associated with a bar code having a subset of N bar code colors from the output of a camera reader and from a color association unit which associates each point in a color space with one of said bar code colors, said color association unit being calibratable to the range of colors that said camera reader is expected to produce given at least one environmental condition in which it operates.

11. A method according to claim 10 and wherein said at least one environmental condition is at least one of the following conditions: a lighting condition, a camera condition and a printed color condition.
12. A method according to claim 10 and wherein said color association unit is a lookup table.
13. A method according to claim 12 and wherein said color association unit is at least two lookup tables, one per lighting condition.
14. A method comprising:
  - generating at least one color chart of color patches of the N bar code colors utilized by a color bar code system; and
  - associating the output of a camera reader upon reading said color chart under varying conditions with said N bar code colors, wherein said output includes a data point per color patch and per condition.
15. A method according to claim 14 and also comprising associating each data point in a color space with one of said N bar code colors using the output of said first step of associating.
16. A method according to claim 15 and wherein said second associating comprises k-nearest neighbor classifying.
17. A method according to claim 16 wherein said k-nearest neighbor classifying comprises:
  - finding at least k neighboring training vectors of a test point;
  - extracting the bar code color associated with each said neighbor;
  - weighting said bar code colors of said neighboring training vectors by the ratio of said bar code colors within the entirety of said training vectors;
  - selecting a majority bar code color;
  - repeating said finding, extracting, weighting and selecting on  $k/2$  and  $2k$  vectors, if no majority was found; and

selecting a majority bar code color from the output of said repeating upon each of said  $k$ ,  $k/2$  and  $2k$  operations.

18. A method according to claim 17 wherein said finding comprises:

extracting all training vectors within a minimum radius;

extracting a minimum of  $k$  nearest neighbors within a maximum radius;

extracting  $k/2$  neighbors from the entire color space; and

repeating said first, second and third steps of extracting until at least  $k$  neighbors have been extracted.